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A SIMPLE TARGET-MAGNET ARRANGEMENT FOR USE WITH THE EXTERNAL PROTON BEAM AT NAL

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A simple target-magnet arrangement, for possible use in Experimental Area 2, is described in this report. The target-magnet makes it possible to obtain charged secondary particle beams at 0° production angle. Estimates of increases in secondary particle beam intensities are given, for 0° production compared with the particle production at finite production angle when the target-magnet is not used.

In the past several years, there have been many studies of targeting arrangements for secondary particle beams produced by external proton beams at accelerators in the 200-500 GeV range[1, 2, 3, 4]. In this note, we describe a single dipole magnet arrangement for possible use in Area 2. This 'target magnet' makes possible the use of 0° production angle for any of the charged secondary particle beams to be located in Area 2.

A large number of charged particle beams have been suggested for NAL Area 2. A typical set of such beams is given in Table I. A plan view schematic layout of production target and secondary beam defining collimators is given in Figure 1. With the target-magnet M "off," target T1 is in use. With the target-magnet M switched on, the target at T2 is used. All the beams now have production angle θ_{prod} = 0 mrad. However, their relative momenta are necessarily coupled (and the ratios of the coupled momenta are the inverse of the ratios of the beam channel angles given in Table I). Thus, with M tuned to collect 150 GeV/c negative particles in Beam 1, the momenta in the other beam channels would be: Beam 2, +94 GeV/c; Beam 3, -44 GeV/c; Beam 4, +37.5 GeV/c; Beam 5, -25 GeV/c; and Beam 6, +25 GeV/c. The advantage of 0° production of the beams is offset by this coupling of the secondary momenta.

Secondary beam intensities can be estimated for this arrangement of beams, using for example the curves given by Awschalom and White[5]. It is of particular interest to see what is the gain, in one particular beam, of obtaining 0° production angle. Table II gives the ratios R of (Production at 0° from T2)/(Production at θ_{prod} from T1) for the 6 beams listed in Table I, for a number of different secondary particles and secondary particle momenta. From Table II, we see that at the highest momenta (except possibly for Beams 1 and 2), the 0° production is quite advantageous. For these high-energy cases, however, we should perhaps choose between use of the target-magnet and performance of the highest energy experiments in Beam 1 or Beam 2.

The reader can form his own opinions of the relative merits of "intensity enhancement by 0° production" versus "independent control of beam momenta." It is the belief of the writer that "independent control" will usually turn out to be the more useful mode of operation. An important feature of the targeting scheme discussed in this note, however, is that both targeting systems can be installed in a single arrangement of apparatus; either targeting system can be used, according to the operator's preference.

A final remark concerns the possibility of the target-magnet being incorrectly set, to give deflection of the EPB protons into the 2.5 mrad or 4.0 mrad beam-lines. This difficulty can be avoided in a number of ways; for example, by displacement of these small-angle beam-lines somewhat out of the median plane (the deflection plane of the target-magnet). A definite arrangement of target-magnet, targets and secondary beam channels, including the vertical angle of displacement of small angle beams, will not be discussed any further here; a decision on the nature of the experimental program in Area 2, and thus on the specific secondary beams to be built, is needed first, before detailed targeting system component arrangements will be designed.

REFERENCES

[1]UCRL-16830, Volumes I, II, and III; "200 BeV Experimental Use": (1964-66).

[2]CERN/EFCA Experimental Utilization Studies, Volumes I, II, and III: (1967).

[3]NAL Design Report, January 1968.

[4]NAL Summer Study Reports: 1968 and 1969.

[5]M. Awschalom and T. White: NAL FN-191.

TABLE I

Possible Beams in Area 2

No.	$\theta_{prod.}$ (mrad)	P_{max} (GeV/c)	ΔP_{min} (GeV/c) at $P = P_{max}$	ΔP_{max} (GeV/c) at $P = P_{max}$	$\Delta\Omega$ (μsr)
1	+ 2.5	200	0.1	2.0	$\leq$ 2.2
2	- 4.0	150	1.5	6.0	$\leq$ 5.0
3	+ 8.5	120	0.1	1.2	$\leq$ 3.5
4	-10.0	100	0.1	1.0	$\leq$ 4.2
5	+15.0	50	0.5	0.5	$\leq$ 27.0
6	-15.0	50	0.1	0.5	$\leq$ 27.0

TABLE II

Relative Particle Yields at 0° and at Finite Production Angles

Beam No.	"$\theta_{prod.}$" (mrad)	Secondary Particle Momentum (GeV/c)	$R = \frac{(0° \text{ yield from T2})}{(\theta_{prod.} \text{ yield from T1})}$		
			R (π^-)	R (K^-)	R ($\bar{p}$)
1	+ 2.5	160	2.0	2.6	2.2
		80	1.4	1.4	1.2
		40	1.1	1.1	1.1
2	- 4.0	150	4.5	4.5	3.5
		75	1.6	1.6	1.5
		37.5	1.1	1.1	1.2
3	+ 8.5	120	85	17	11
		60	4.0	2.5	2.0
		30	1.7	1.4	1.3
4	-10.0	100	30	9.5	6.0
		50	3.0	2.3	2.0
		25	1.4	1.3	1.3
5	+15.0	50	12	4.5	3.6
		25	2.5	1.8	1.5
		12.5	1.4	1.2	1.2
6	-15.0	50	12	4.5	3.6
		25	2.5	1.8	1.5
		12.5	1.4	1.2	1.2

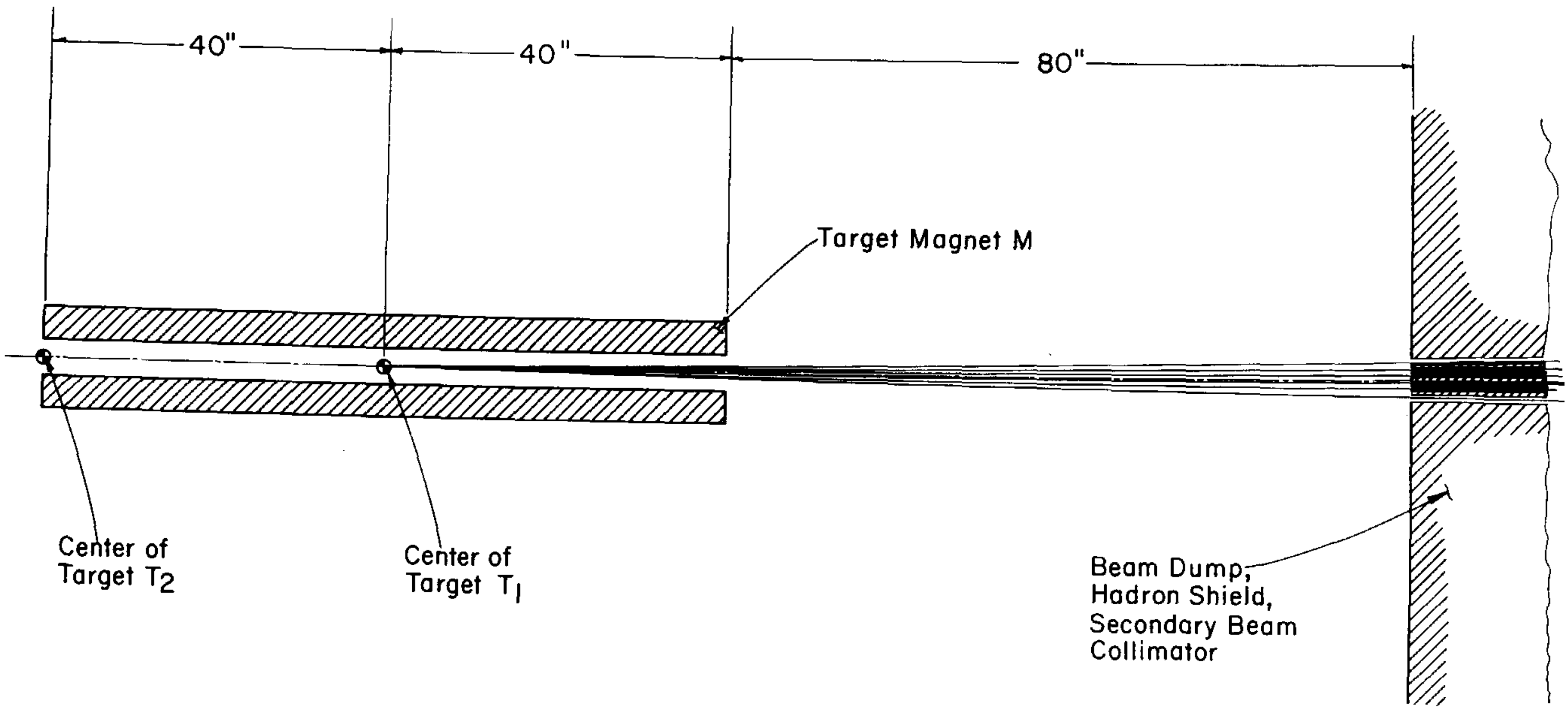

Fig. 1 - Target and Dispersion Magnet Arrangement